NATIONAL BUREAU OF STANDARDS REPORT

10 330

ISO NONCOMBUSTIBILITY FURNACE

NBS

U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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The Bureau comprises the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, the Center for Radiation Research, the Center for Computer Sciences and Technology, and the Office for Information Programs.

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Office of Standard Reference Data—Clearinghouse for Federal Scientific and Technical Information [3]—Office of Technical Information and Publications—Library—Office of Public Information—Office of International Relations.

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.
[2] Located at Boulder, Colorado 80302.
[3] Located at 5285 Port Royal Road, Springfield, Virginia 22151.

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ISO NONCOMBUSTIBILITY FURNACE

by

I. A. Benjamin

Prepared For

U. S. Coast Guard
MIPR Number Z-70099-0-04091

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U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
WASHINGTON, D.C. 20234

PRELIMINARY

REPORT OF TEST

on

ISO Noncombustibility Furnace

for

United States Coast Guard

Report No. TG10210-2195:FR3732

1.0 INTRODUCTION

At the request of the United States Coast Guard, MIPR-Z-70099-0-04091, dated 9 June 1970 a study was initiated on the variables in the ISO test method for non-combustibility - to improve the test procedures. This program involved:

(a) Construction of complete new furnace and stand.

(b) Vertical and horizontal temperature traverses.

(c) Tests of three materials per each condition described in Table II.

2.0 CONSTRUCTION

The stand, furnace and specimen insertion device were constructed as per Figure 1. The following materials were used for fabrication of furnace:

Refractory Tube -	Alumina AN-192 I.D. - 3" Density 2.9g/cc O.D. - 3 3/4" Wall thickness 3/8" Height 6"
Refractory Cement -	Alundum - EA - 162
Insulation -	Cerafelt 6 PCF Thickness 1"
Windings -	Chromel - A - Ribbon 1/8" x .010" Resistance per foot - .429 Ω
Furnace Shell -	14 gauge steel .0747
Liner - top & bottom	Marinite 3/4"

Draught Shield - 20 gauge steel - $\approx$1 mm
I.D. - 3"

Air Flow Stabilizer - 20 gauge steel - $\approx$1 mm

Stand - 1/8 x 1" steel angle

Draught Shield (Stand) - 14 gauge steel

The refractory tube was first given a thin coat of grout with the Alundum Cement to provide a smooth surface for better contact of the heater winding. The windings were wrapped as tightly as possible to insure maximum contact with the refractory tube and were oriented in this manner:

	Width	Length	Turns	Resistance/Winding
Top Windings	2"	8'	8	3.4 Ω
Center Windings	1"	4.65'	5	2.2 Ω
Bottom Windings	2"	10'	10	4.4 Ω

A 1/16" coat of Alundum Cement was put over the winding and the assembly was placed in a muffle furnace to dry. Both coats of cement were dried individually and kept below 100 °C for 2 hours. The temperature was then allowed to increase at a rate of 600 °C per hour to 1000 °C for 1-1/2 hours. The total weight of tube, windings and cement was approximately 4 lbs. (1.81 kg). The furnace construction was then completed and made ready for testing.

3.0 TEST METHOD

The three furnace windings were connected to separate Variac voltage controllers, which received power from a constant voltage source of 115 V. A record of the different furnace conditions and the voltage required to obtain the designated temperature within a 60 mm range are shown in Table I.

Vertical and horizontal traverses are shown for the conditions in Figures 2 through 10.

3.1 SPECIMEN HOLDER (CYLINDRICAL)

It was found to be quite inconvenient to insert specimen in the holder suggested by Denmark, because it involved passing the specimen between the four legs required to hold the perforated base plate and then assembling the holder. Figure 11 suggests a three-legged holder with the base plate mounted permanently. The specimen is inserted from the side and the center thermocouple is returned to its predetermined position. This method was found to work more satisfactorily.

4.0 TEST MATERIALS

The materials used for the test samples were known to have a wide combustibility range, with the fibrous glass material known to pass and the mineral wool and asbestos plus 6% wood fiber to fail the existing ISO criteria.

	Code	Material	Thickness	Density lb/ft^3
(1)	A	Asbestos + 6% wood	1"	37
(2)	W	Mineral wool	2"	8
(3)	G	Glass fiber	2"	2.8

All materials were cut to size and conditioned in an oven at 60 °C ± 5 °C for 24 hours and then cooled to ambient temperature in a desiccator prior to the test. Results are shown on Table II.

5.0 OBSERVATIONS

This experiment was designed for statistical analysis of variance. The analysis has not been completed and therefore the data is presented herein for information only.

Neither the contents of this report nor the fact that the tests were made at the National Bureau of Standards shall be used for advertising or promotional purposes.

For the Director

by Irwin Benjamin

IRWIN A. BENJAMIN
Chief, Fire Research Section
Building Research Division, IAT

August 28, 1970

TABLE I

ISO Non-combustibility Furnace

Condition	Avg Temp @ 60 mm Range	KW	Windings (Volts)		
			Top	Center	Bottom
1. Cone Insulation Only* Diffuser Screen** IMCO Holder (Square)	751 ± 6	.85	31.5	off	44
2. Cone Insulation Diffuser Screen Danish Holder (Cylindrical)	750 ± 5	.88	34	off	45
3. Cone Insulation W/O Diffuser Screen IMCO Holder	747 ± 10	.98	36	4	47
4. W/O Insulation W/O Diffuser Screen IMCO Holder	751 ± 7	.89	32	off	46.5
5. Cone Insulation W/O Diffuser Screen Danish Holder	750 ± 3	.91	37	5	44
6. W/O Cone Insulation W/O Diffuser Screen Danish Holder	748 ± 5	.89	32	off	47.5
7. W/O Cone Insulation W/O Diffuser Screen IMCO Holder	750 ± 7	1.02	37	6	45
8. W/O Cone Insulation W/O Diffuser Screen Danish Holder	750 ± 7	.99	38.5	6.5	45

* Cone Insulation - Cerafelt, 6 pcf, 1" x 7"
** Diffuser Screen - 16 mesh heat resisting steel, 4" x 4"

TABLE II - Test Results

Condition	Peak Surface Temp °C			Time to Peak (min)			Peak Center Temp °C			Time to Peak (min)			Time to Fail P = Pass		
	A	W	G	A	W	G	A	W	G	A	W	G	A	W	G
1. Cone Insulation Diffuser Screen IMCO Holder Round Sample	782	766	755	15.7	2.2	0.5	1050	861	789	<20.0	1.75	1.0	16.75	1.5	P
2. Cone Insulation Diffuser Screen Danish Holder Square Sample	778	777	760	13.0	1.5	0.3	1080	857	790	18.5	1.4	0.8	14.8	1.4	P
3. Cone Insulation W/O Diffuser Screen IMCO Holder Square Sample	822	793	797	9.2	1.5	1.0	1072	872	763	15.3	1.3	0.4	12.5	1.2	P
4. W/O Cone Insulation Diffuser Screen IMCO Holder Square Sample	795	778	755	12.25	1	0.5	1082	835	792	17.5	1.3	0.8	13.75	1.3	P
5. Cone Insulation W/O Diffuser Screen * Danish Holder Round Sample	791 815 822	790 786 788	759 763 775	10.8 12.0 10.0	2.5 2.0 2.0	0.5 0.4 0.5	1067 1100 1090	883 874 860	793 790 792	19.0 19.3 18.0	1.6 1.6 1.7	0.7 0.9 0.9	15.0 15.5 14.0	1.4 1.5 1.6	P P P
6. W/O Cone Insulation Diffuser Screen Danish Holder Round Sample	783	777	776	14.7	2.0	0.6	<935	867	794	20.0	1.6	0.9	17.5	1.4	P
7. W/O Cone Insulation W/O Diffuser Screen IMCO Holder Round Sample	815 800	793 800	765 765	9.8 10.5	1.5 2.0	0.5 0.4	1091 1107	878 860	822 796	16.5 17.4	1.4 1.5	0.9 0.9	13.0 13.3	1.3 1.3	0.85 P
8. W/O Cone Insulation W/O Diffuser Screen Danish Holder Square Sample	817	798	770	10.5	1.9	0.4	1109	857	785	17.5	1.5	1.0	13.75	1.4	P

* A series of three tests were made for comparison. The furnace condition #5 had the best average temperature distribution within the required range of 750 ± 5.

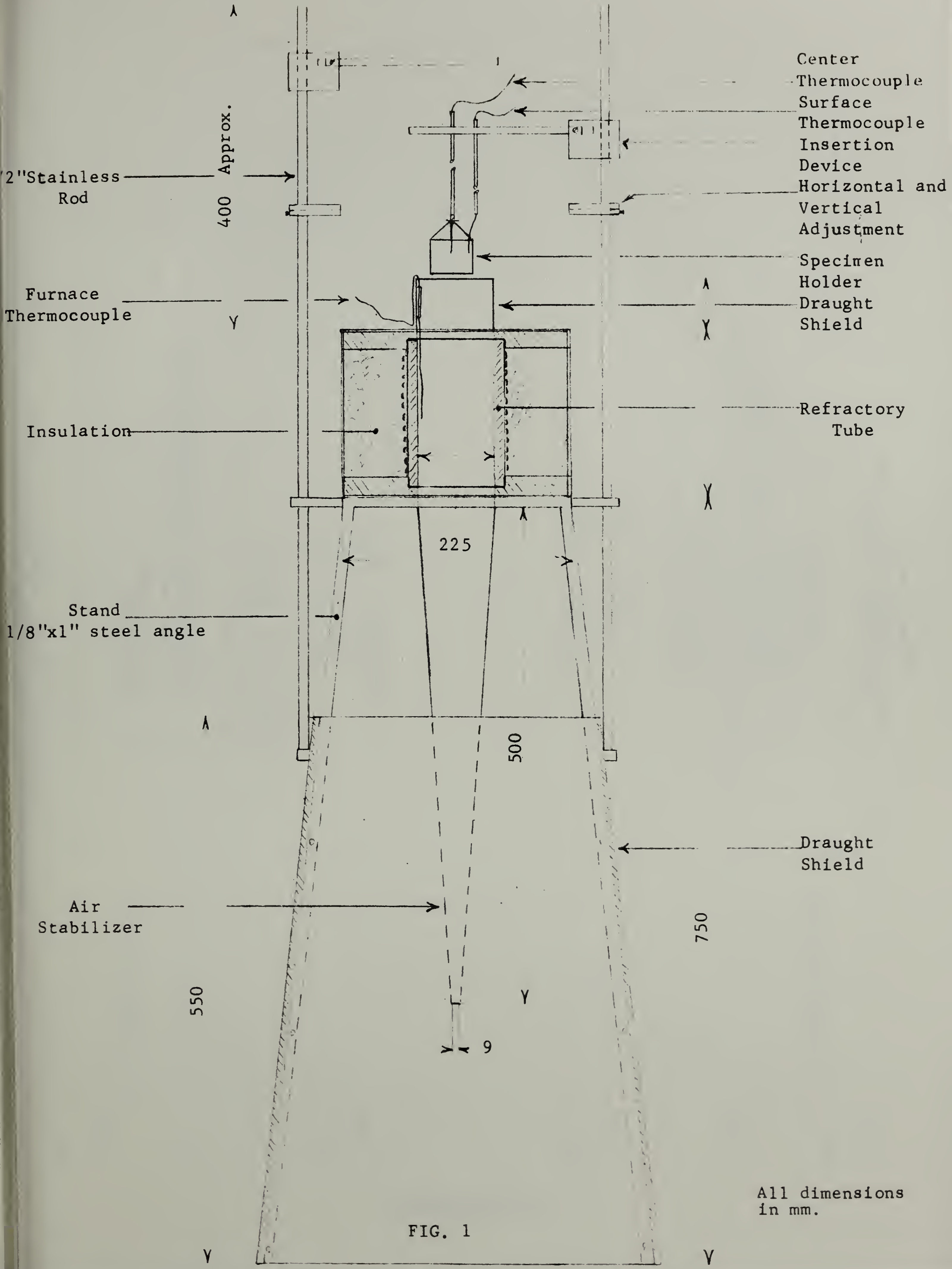
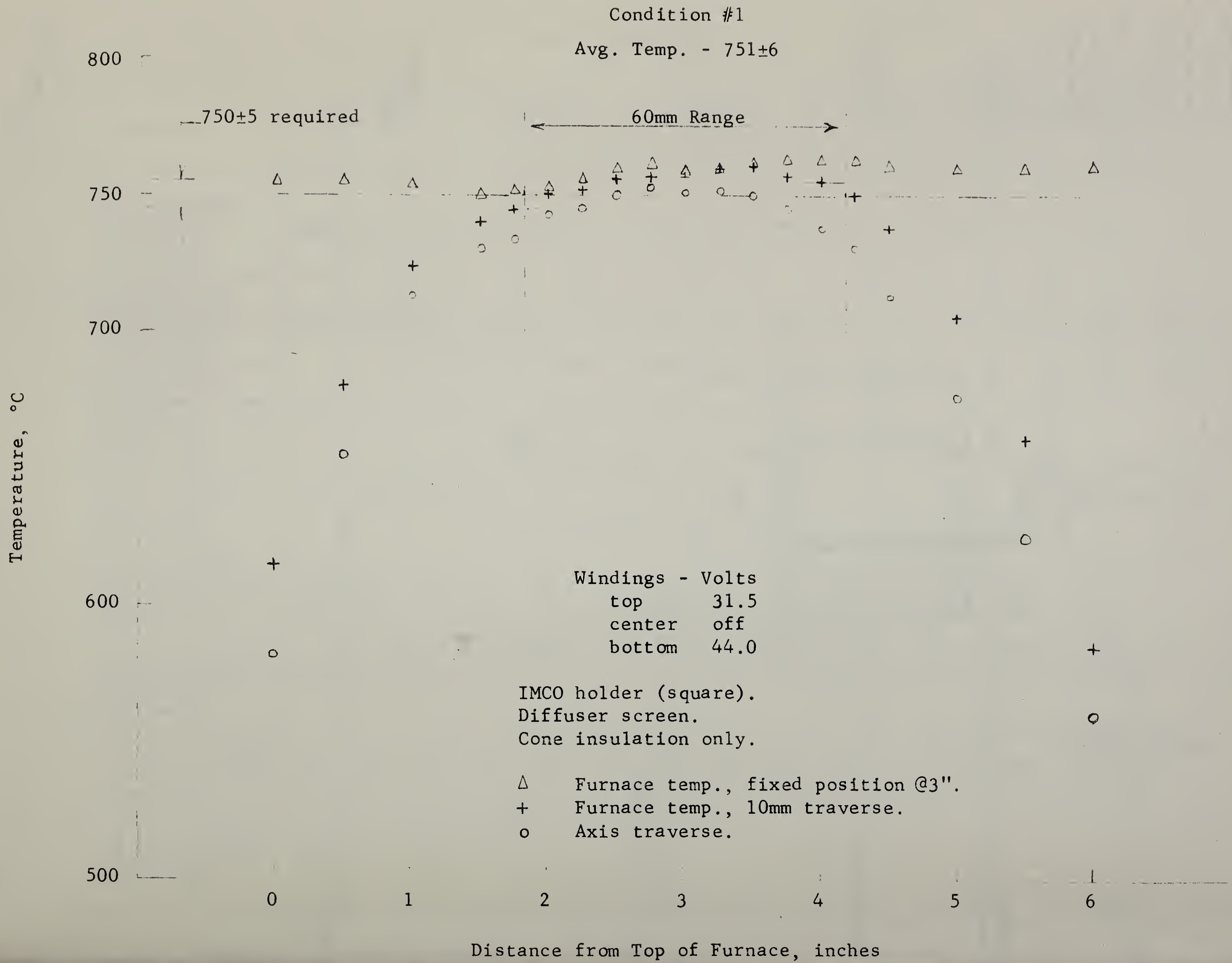


FIG. 1

General Arrangement - Non-combustibility Apparatus


Condition #1
Avg. Temp. - 751±6
750±5 required
60mm Range
800
750
700
600
500
Temperature, °C
Windings - Volts
top 31.5
center off
bottom 44.0
IMCO holder (square).
Diffuser screen.
Cone insulation only.
Δ Furnace temp., fixed position @3".
+ Furnace temp., 10mm traverse.
o Axis traverse.
0
1
2
3
4
5
6
Distance from Top of Furnace, inches
FIG. 2

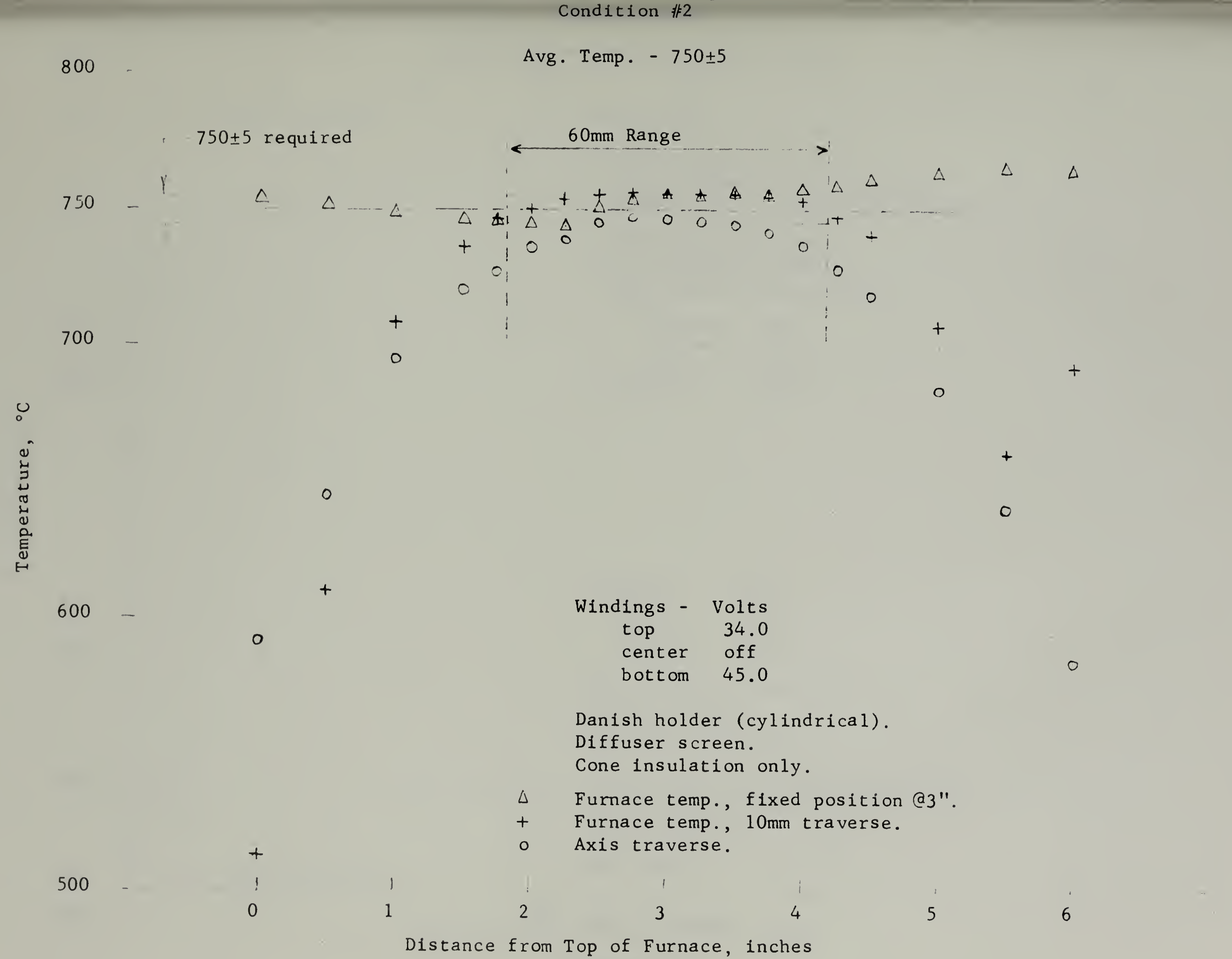

Condition #2
Avg. Temp. - 750±5
750±5 required
60mm Range
800
750
700
600
500
Temperature, °C
0
1
2
3
4
5
6
Distance from Top of Furnace, inches
Windings - Volts
top 34.0
center off
bottom 45.0
Danish holder (cylindrical).
Diffuser screen.
Cone insulation only.
△ Furnace temp., fixed position @3".
+ Furnace temp., 10mm traverse.
o Axis traverse.

FIG. 3

Condition #3

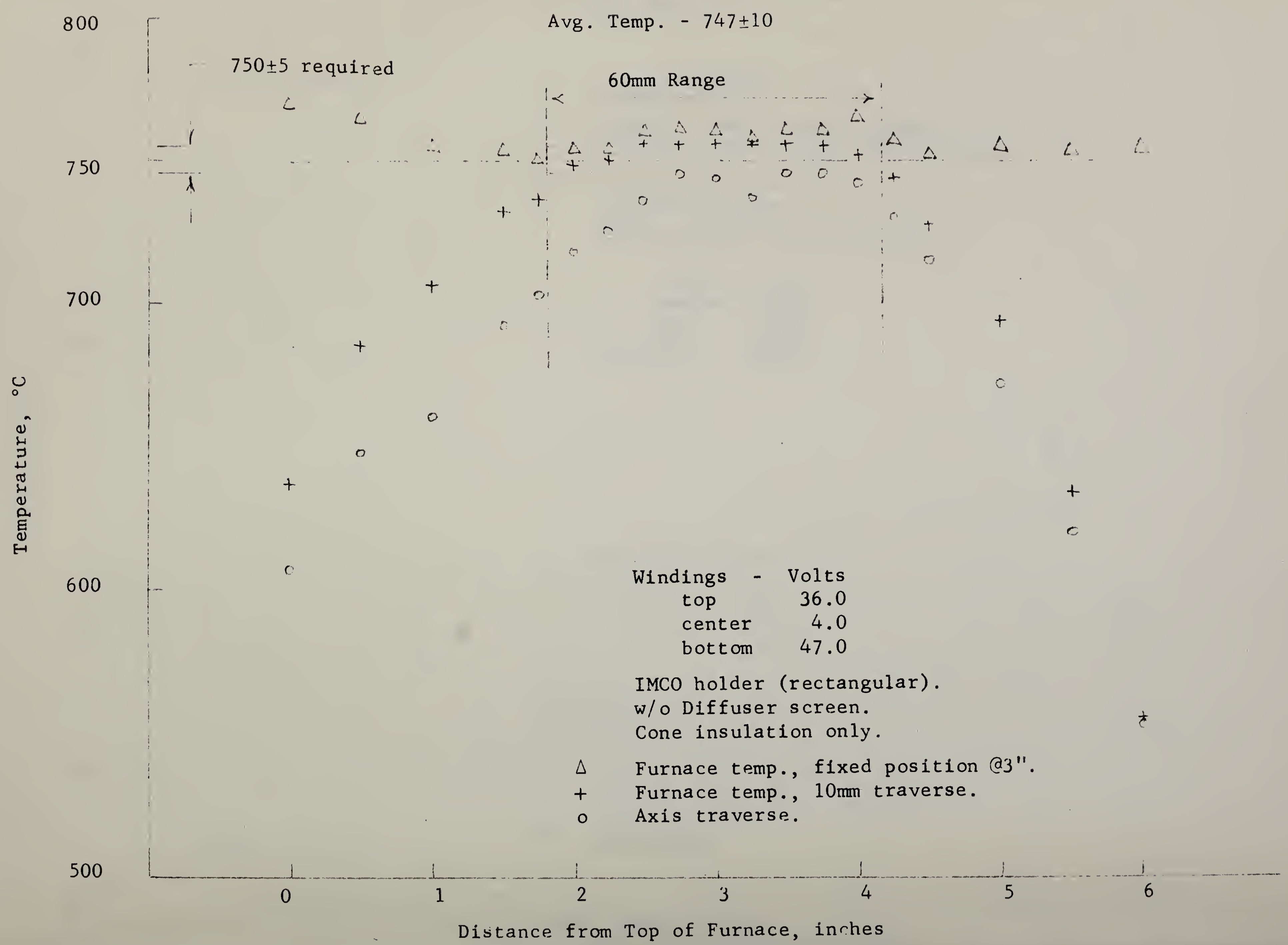


FIG. 4

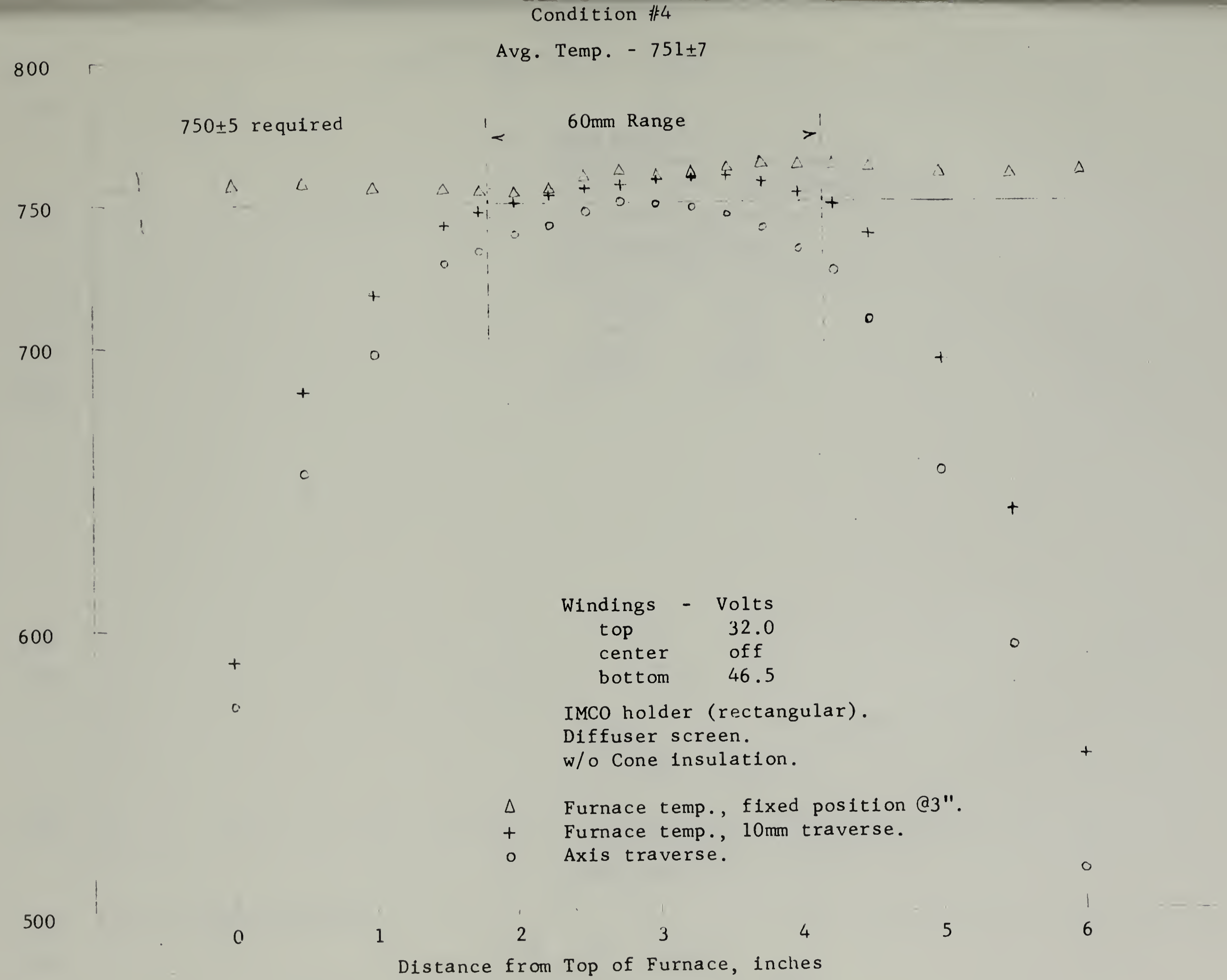
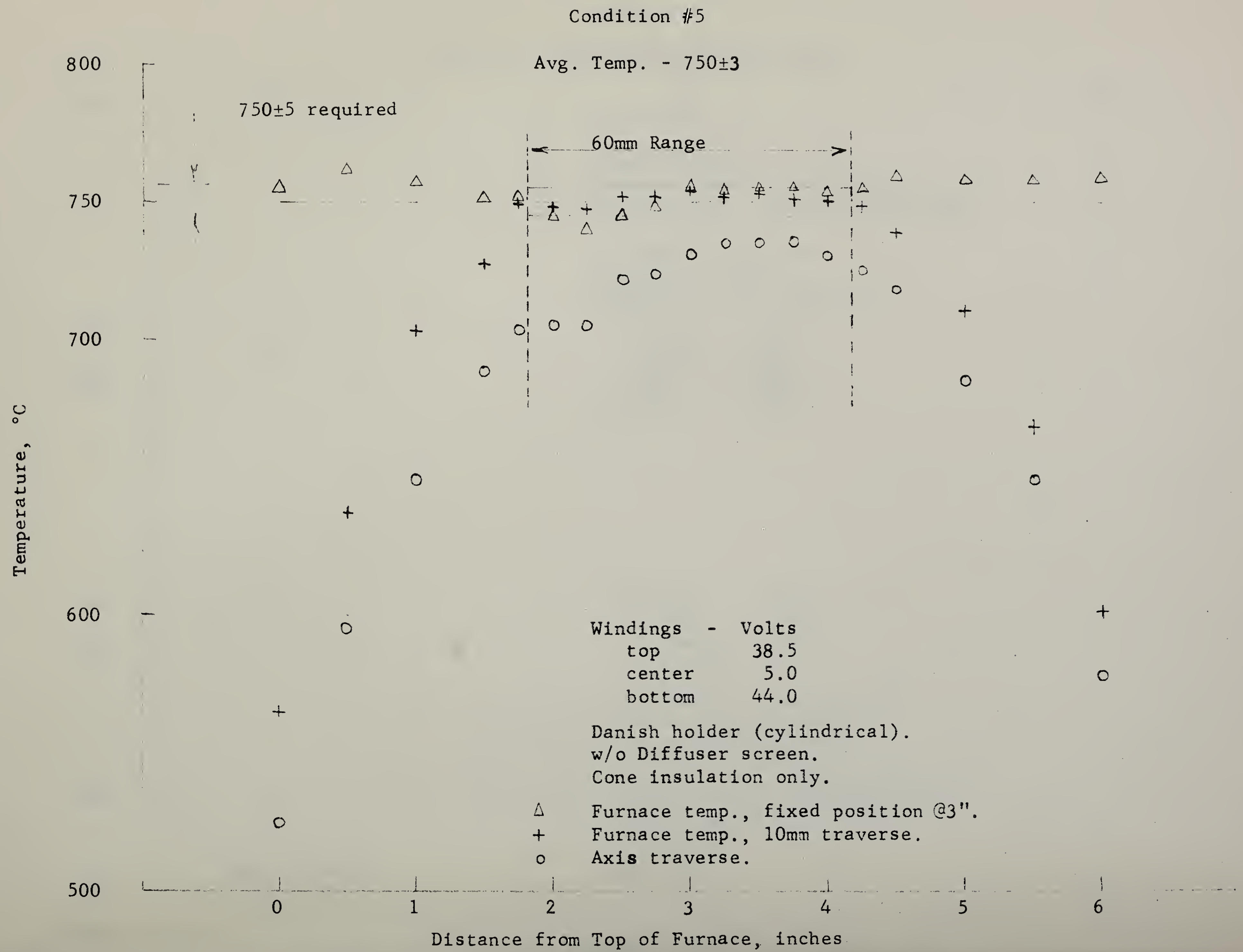

Condition #4
Avg. Temp. - 751±7
800
750
700
600
500
750±5 required
60mm Range
Windings - Volts
top 32.0
center off
bottom 46.5
IMCO holder (rectangular).
Diffuser screen.
w/o Cone insulation.
Δ Furnace temp., fixed position @3".
+ Furnace temp., 10mm traverse.
o Axis traverse.
0
1
2
3
4
5
6
Distance from Top of Furnace, inches

FIG. 5



Condition #5
Avg. Temp. - 750±3
750±5 required
60mm Range
800
750
700
600
500
Temperature, °C
Windings - Volts
top 38.5
center 5.0
bottom 44.0
Danish holder (cylindrical).
w/o Diffuser screen.
Cone insulation only.
Δ Furnace temp., fixed position @3".
+ Furnace temp., 10mm traverse.
o Axis traverse.
0
1
2
3
4
5
6
Distance from Top of Furnace, inches

FIG. 6

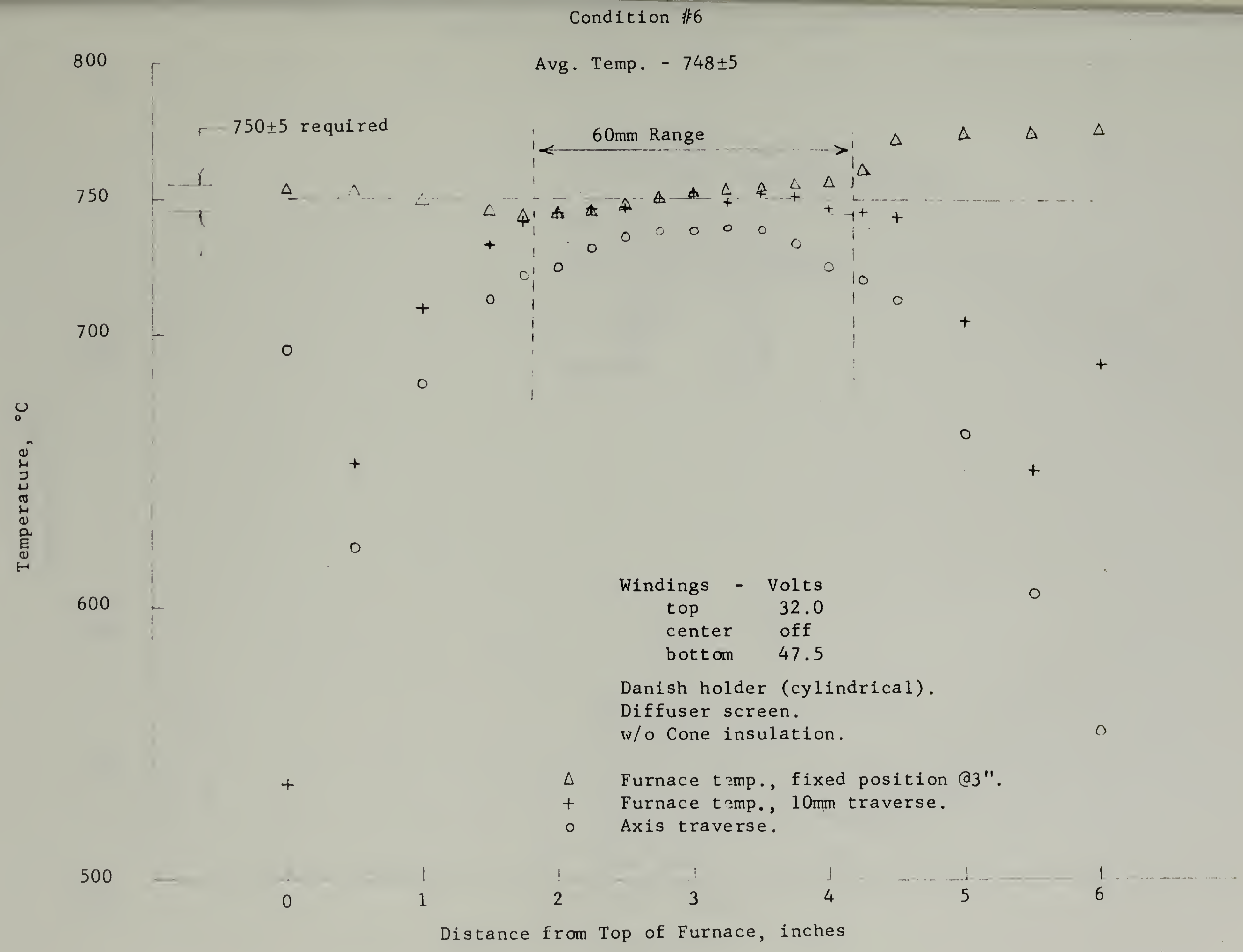
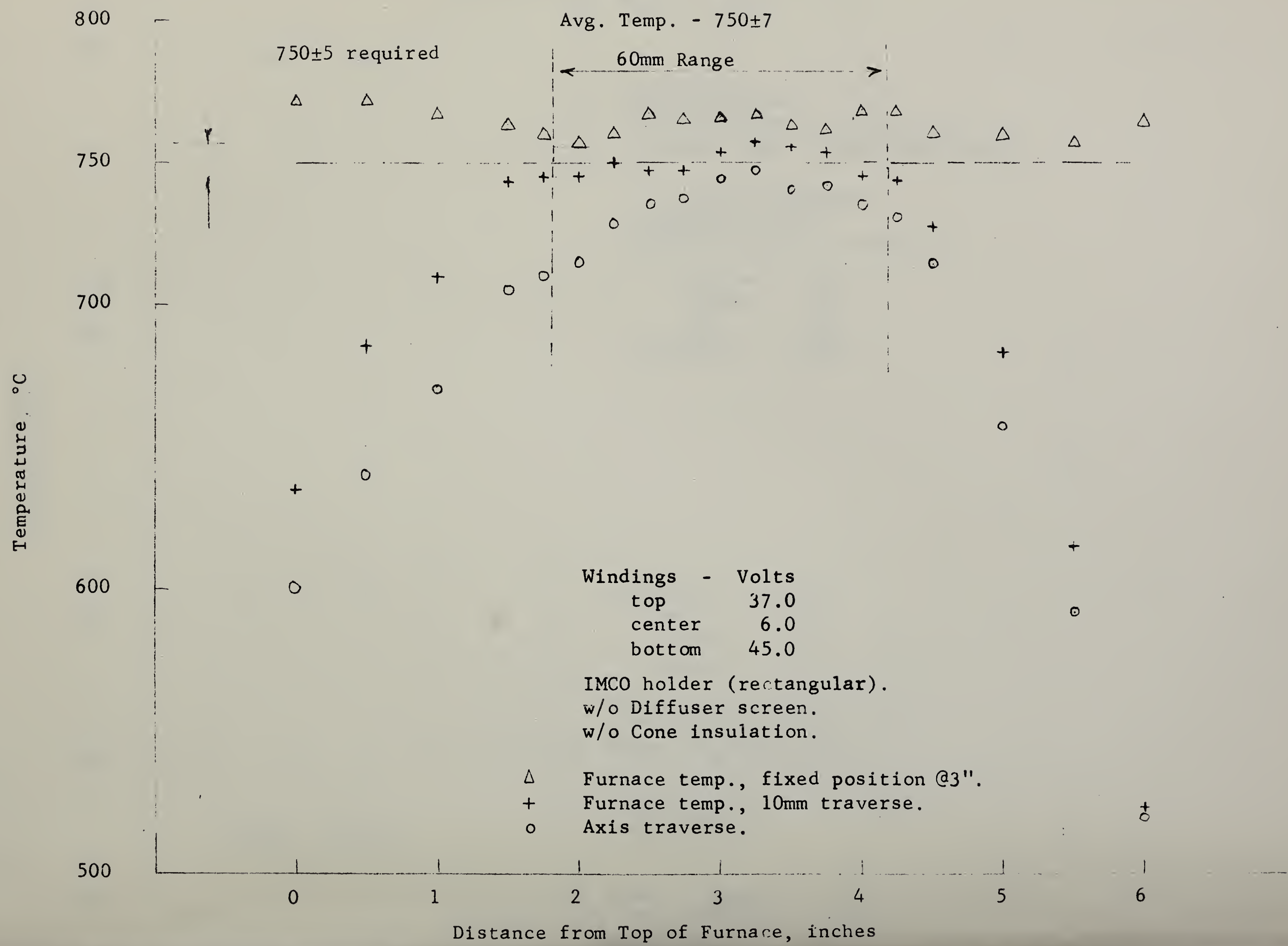

Condition #6
Avg. Temp. - 748±5
750±5 required
60mm Range
Temperature, °C
800
750
700
600
500
0
1
2
3
4
5
6
Distance from Top of Furnace, inches
Windings - Volts
top 32.0
center off
bottom 47.5
Danish holder (cylindrical).
Diffuser screen.
w/o Cone insulation.
Δ Furnace temp., fixed position @3".
+ Furnace temp., 10mm traverse.
o Axis traverse.

FIG. 7

Condition #7


Avg. Temp. - 750±7
750±5 required
60mm Range
800
750
700
600
500
Temperature °C
0
1
2
3
4
5
6
Distance from Top of Furnace, inches
Windings - Volts
top 37.0
center 6.0
bottom 45.0
IMCO holder (rectangular).
w/o Diffuser screen.
w/o Cone insulation.
Δ Furnace temp., fixed position @3".
+ Furnace temp., 10mm traverse.
o Axis traverse.

Condition #8

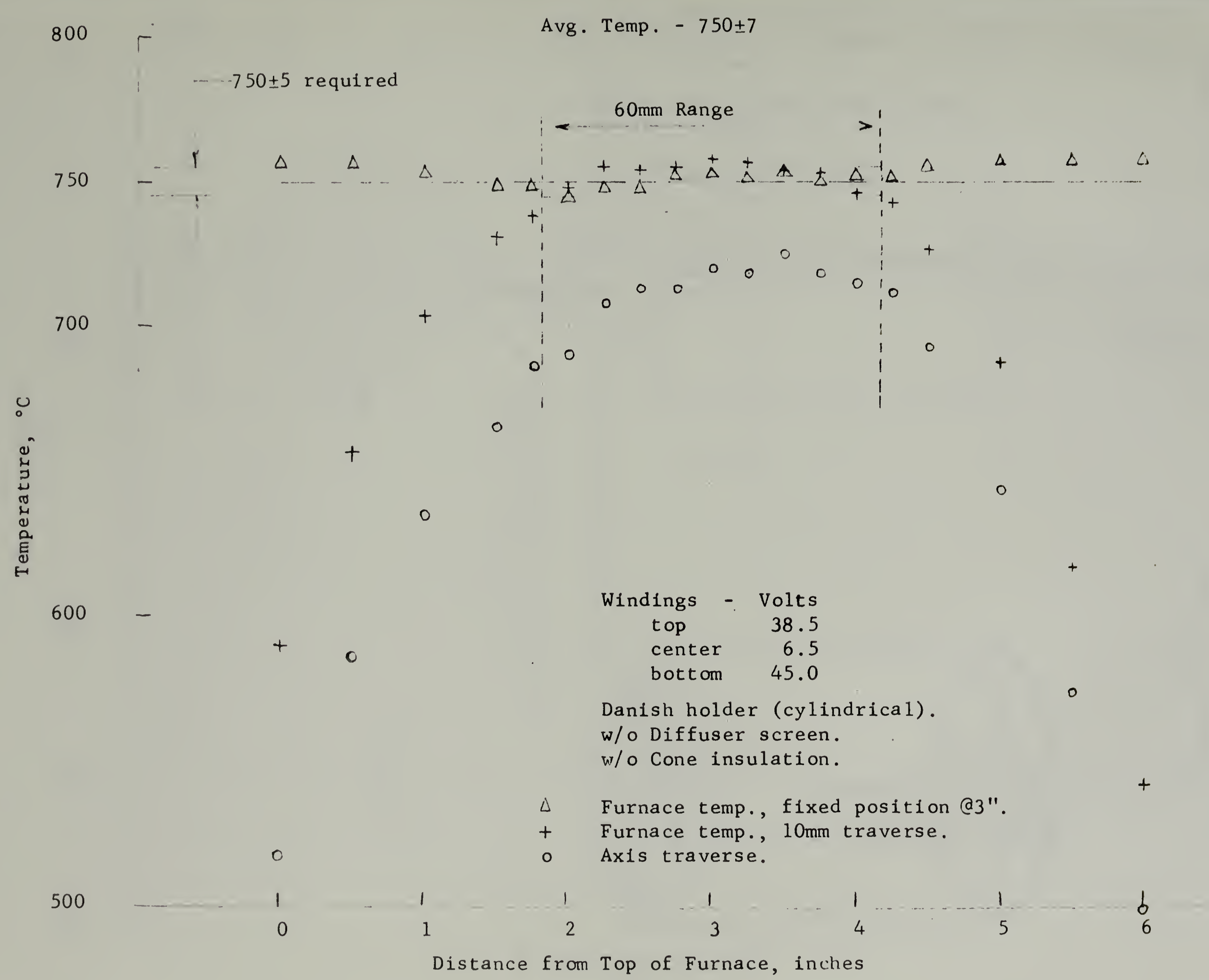
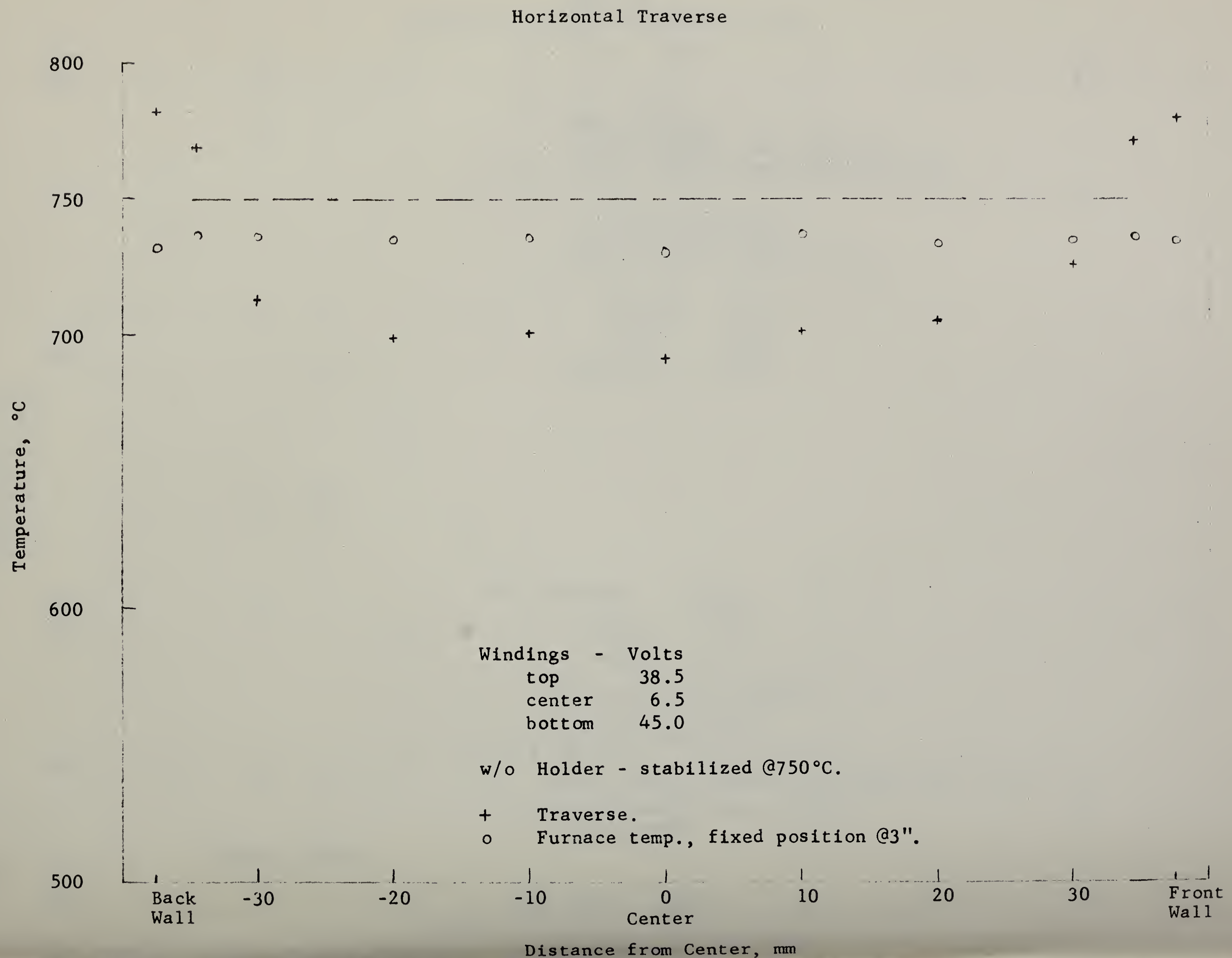


FIG. 9


Horizontal Traverse
800
750
700
600
500
Temperature, °C
Windings - Volts
top 38.5
center 6.5
bottom 45.0
w/o Holder - stabilized @750°C.
+ Traverse.
o Furnace temp., fixed position @3".
Back Wall
-30
-20
-10
0
Center
10
20
30
Front Wall
Distance from Center, mm

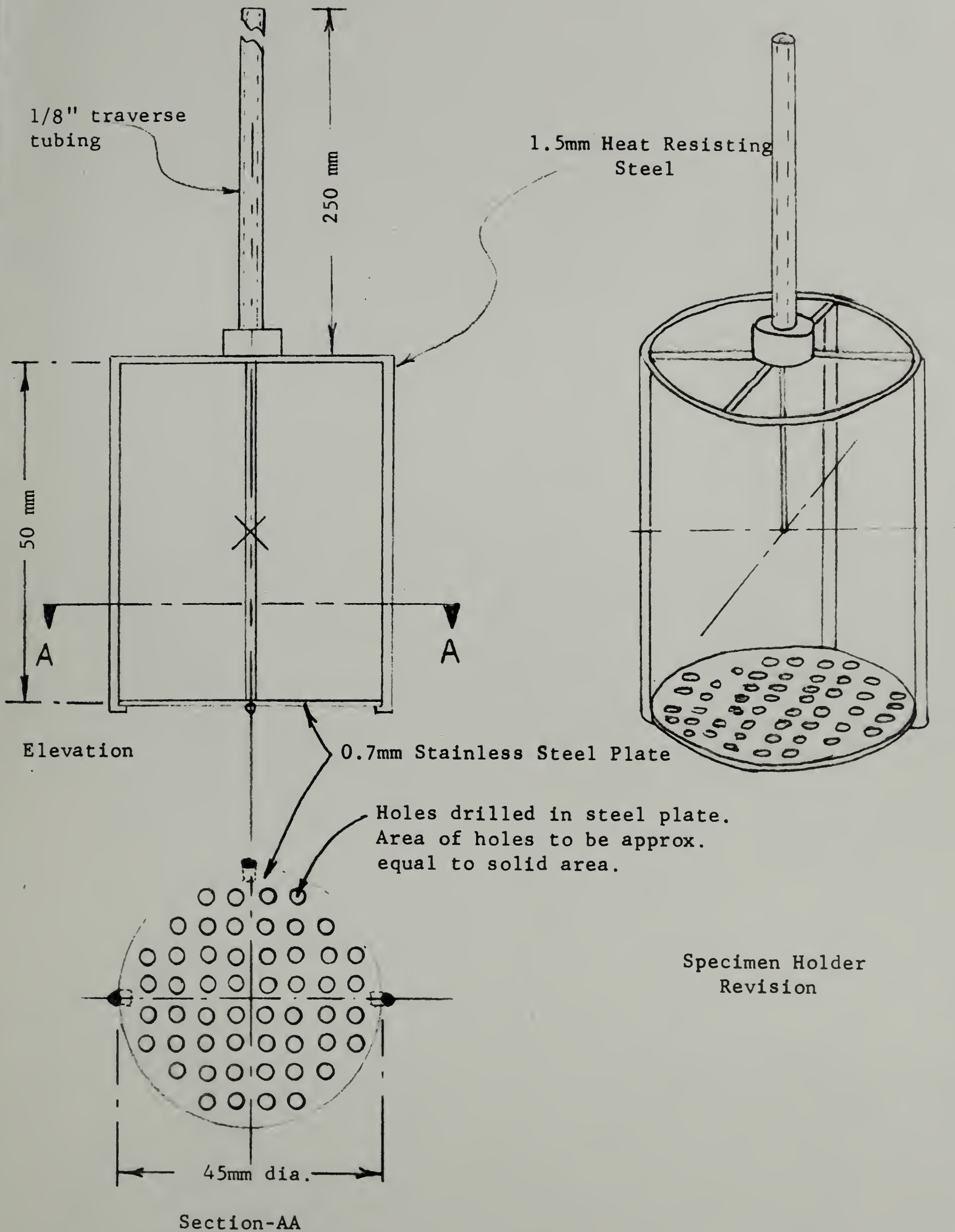

1/8" traverse tubing
250 mm
1.5mm Heat Resisting Steel
50 mm
A
A
Elevation
0.7mm Stainless Steel Plate
Holes drilled in steel plate. Area of holes to be approx. equal to solid area.
45mm dia.
Section-AA
Specimen Holder Revision

FIG. 11

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